

## PIPING SYSTEMS

1. General. In general, piping should not penetrate a levee embankment or foundation. The recommended placement is in a levee crest within the freeboard zone. Construction of a piping system through a levee embankment or its foundation must be justified based on technical criteria and merits. A minimum diameter pipe of 48 inches on major urban levees and 36 inches on rural levees should be used to facilitate installation, maintenance and inspection. Reinforced concrete pipe should be used for gravity drainage through urban levees. Pressurized pipes should be concrete, cast in place concrete, ductile iron or welded steel.

2. Pipes placed over or within the freeboard zone of a levee embankment.

2.1. The recommended placement of a pipe within a levee freeboard zone is shown in Figure 1.

2.2. The backfill on a levee crest and levee slopes covered with grass should be sloped on 1V on 10H to allow for traffic on the levee crest and mowing equipment on the levee slope.

2.3. The backfill should provide a minimum of 1 foot of coverage above the top of the pipe on a levee slopes and at least 2 feet on a levee crest, and should consist of compacted impervious material on a levee crest and riverside slope. Random material can be used on the landside slope if the soil will support grass growth.

2.4. The pipe should not be buried more than 1 foot in a levee embankment on the riverside slope.

2.5. Pipes passing over or within the freeboard zone of a levee should be limited to metal pipes, preferably ductile iron or coated steel, suitable for use with flexible couplings. Pipes over the levee require an air release and a siphon breaker at the crest. If installation of a siphon breaker is not feasible provisions shall be made for closure on the waterside of the levee accessible from the levee crest. If the pipe cannot act as a siphon, a permanent vent opening can be used. Pipes within the freeboard zone should have provisions for closure on the waterside of the levee accessible from the levee crest.

3. Pipes placed within a levee embankment, or in the critical area of a flood control structure.

3.1. Pressurized pumping station discharge piping under a levee or through a floodwall or levee should be avoided.

3.2. If it is not feasible to place a discharge pipe over a levee, the pipe must have adequate strength and be provided with water tight joints that accommodate differential movements while limiting axial movement.

3.3. For pipes passing through a levee embankment or flood protection structure foundation, either a gate valve or a sluice gate should be provided and housed in a gatewell. The gatewell should be located so as to provide personnel access to the gate from the top of the levee.

3.4. Pipes located within or beneath a levee embankment or in the critical area must have watertight joints. RCP with either steel or concrete bell- and spigot surfaces and solid "O-ring" rubber gaskets having a circular cross sectional should be used.

3.5. At pipe connections to concrete structures, articulated joints must be provided in the pipes at the exterior wall face of the structure. Two half-lengths of pipe should be used at each structure connection to provide flexibility.

3.6. Cast-in-place manholes should be used on major levees. Precast manholes may be used on less critical levees. All joints must be watertight.

3.7. If precast concrete manholes or curb inlets are used, the bottom wall ring should project at least 3 inches into the base slab to insure water tightness in these structures. The structures must utilize "O-ring" rubber gaskets in each wall joint. Joint mating surfaces must be parallel to the walls (modified tongue and groove joint), not sloped. Gasket spaces between the tongue and groove should provide containment grooves to accept and prevent the gasket from disengaging from the compression surface or being blown out by hydrostatic pressure.

3.8. All manhole and other structures related to the piping system should be designed and constructed to conform to the topic STRUCTURES.

3.9. All pipes and structures related to the piping system should be analyzed for uplift based on hydraulic gradients determined in accordance with the topic UNDERSEEPAGE. The uplift calculations should conform to the topic UPLIFT.

#### 4. Use of Plastic, Fiberglass, and Other Flexible Pipes.

4.1. Corrugated Metal Pipes (CMP). CMP is not allowed in the levee embankment or foundation of urban levees. Coated CMP with 1 inch bituminous coating inside and outside of the pipe can be used on agricultural levees where levee embankments are no more than 12 feet above the pipe invert. Corrugated metal pipes should be minimum 36 inches in diameter.

4.2. Plastic Pipes and Fiberglass Pipes: Plastic and fiberglass pipes are designed to work in tandem with granular bedding and backfill material in the pipe envelope (sometimes referred to as embedment). The cohesive soils used in the levee critical area can result in excessive deflection of plastic pipes, which will usually preclude the use of these pipes in impervious zones of the levee critical areas. EM 1110-2-2902 prohibits the use of plastic pipes through levees. The following guidance is applicable if plastic, fiberglass or flexible pipes are to be used in other locations within the critical area.

4.2.1. Plastic pipe should only be used with granular backfill materials such as those listed in ASTM D 2321 as Class I and II. Class I and II materials are usually not acceptable in the levee critical area unless they replace similar existing fill.

4.2.2. Installation shall be in accordance with ASTM D 2321, except when flowable backfill is

used. In either case pipe embedment should be as shown in ASTM D 2321. Concrete cradles should not be used.

4.2.3. Details on the type of bedding and backfill that will be used for the plastic pipes, and calculations demonstrating that the backfill provides sufficient structural support for the pipe must be provided. See paragraph 5. for excavation and backfill requirements.

4.2.4. A flotation check is required.

5. Excavation and backfill for installation of piping system should conform to the topic EXCAVATION AND BACKFILL. All pipe backfill material in the critical area of the flood control project must be impervious material. No granular bedding is accepted in this area. The minimum compaction requirements are as required in EXCAVATION AND BACKFILL. The use of flowable backfill to replace the pipe embedment materials is an option. The material should be easily removed in case the pipe needs to be replaced in the future. Flowable backfill should have a maximum compressive strength of 500 pounds per square inch. Design of the pipe/flowable backfill system must be presented for review and acceptance. Rationale must be provided for the design input values, such as the horizontal soil modulus equivalent of the flowable backfill to be used. Flowable concrete does not adhere to plastics and will require rubber waterstops (gaskets) to prevent seepage along the pipeline. Design of the pipe/flowable backfill system must be provided.

6. Pipes located in corrosive environment should conform to Section: STRUCTURES.

7. Abandonment of piping system.

7.1. Removal of piping system. The preferred method of piping system abandonment within the critical area is complete removal. The excavation and backfill for removal of the piping system should comply with the topic EXCAVATION AND BACKFILL. Details of piping system removal should be provided to the Corps for review.

7.2. If removal of the pipes and other structures related to the piping system is not feasible, the pipes and the other structures should be grouted full with a grout based on cement-bentonite, or flowable fill. The grout or flowable fill mix should be approved by the Corps of Engineers. The grout shall be fluid enough, and pumped in the "up-slope" direction, so that the pipe will be completely filled leaving no voids. Points of access need to be made into the pipe at sufficient intervals to accomplish the grouting.

8. Recommended references. The following references contain details regarding COE requirements for the design and construction of a piping system within the critical area of a flood control project constructed by the COE.

8.1. EM 1110-2-2902, CONDUITS, CULVERTS AND PIPES, includes the following information.

a. Details regarding reinforced concrete pipes (RCP) materials, methods of analysis,

installation, joints, and camber.

b. Details regarding corrugated metal pipes (CMP) materials, methods of analysis, installation, joints, and camber.

c. Details for design and construction for concrete culverts.

d. Details for design and construction for plastic, ductile iron and steel pipes.

8.2. EM 1110-2-3102, GENERAL PRINCIPLES OF PUMPING STATION DESIGN AND LAYOUT, defines the criteria for Pumping Station discharge lines.

8.3. EM 1110-2-3104, STRUCTURAL AND ARCHITECTURAL DESIGN OF PUMPING STATIONS, addresses design criteria for pressurized discharge systems.

8.4. EM 1110-2-3105, MECHANICAL AND ELECTRICAL DESIGN OF PUMPING STATIONS, addresses discharge systems requirements through flood protection projects or over a levee.

8.5. EM 1110-2-1813, DESIGN & CONSTRUCTION OF LEVEES, addresses requirements for pipelines and other utility lines crossing levees.

[Figure 1 – PIPELINE CROSSING A LEVEE](#)